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COMMENTS ON DOPPLER RADAR APPLICATIONS

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By correspondence from your Chairman, I have been invited to serve as a sort of "devil's advocate," and to contribute to a balanced view of Doppler radar applications. Since I substantially agree with Dr. Lhermitte, the brief comments below are presented only with the thought of shifting some of the points of emphasis.

Dr. Lhermitte's report, following the Terms of Reference of the Panel and the suggested format for review papers, discusses the experimental techniques before their meteorological relevance. There should be many competent scientists dedicated to the advance of scientific instrumentation, but we note the dichotomy that exists between groups whose first concern is with problems of applications and those groups which primarily consider the instrument to be applied. This situation is recognized in the Panel's Terms of Reference, which requests recommendations concerning "means of encouraging meteorological participation in remote sensing programs." However, some meteorologists may be legitimately uninterested in some kinds of remote atmospheric sensing, and we should consider the distinction between application of remote sensing data for understanding meteorological processes, and the use of such data by the weather science services. A panel of meteorologists might well encourage more participation by remote-sensing specialists in meteorology programs!

The relatively small size and transitory nature of severe local storms have been serious impediments to their observation by conventional means, and we are especially pressed to develop remote probes for use in these cases. I would certainly expect continuation of the kinds of multi-Doppler studies discussed by Dr. Lhermitte, with emphasis placed where there is most relevance to important theoretical or applied meteorological problems. For example, Doppler methods may provide improved estimates of the field of air motions in thunderstorms -- fundamental parameters are the rotational properties of thunderstorm air and the distribution and magnitude of air mass sources and sinks. Measurements of air flow at particular points when linked with the equations of continuity for moisture and wind and the equations of dynamical meteorology, should help greatly to define the physical basis of severe local storms.

While having great interest and concern for advanced problems, let us not leap-frog apparently simpler problems which have great practical importance. For example, the community of aviation interests requires measurements of turbulence in storms, more representative than the indications of reflectivity measurements. The R-meter concept first developed at MIT over 10 years ago, but never fairly tried, offers one possibility for such turbulence measurement. The R-meter displays the rate of echo amplitude level crossings, which indicates the width of the Doppler spectrum. Full Doppler capability is not required for level crossing measurements, but only a conventional radar with a very stable magnetron. This approach might also enable us to identify a tornado, or better, an incipient tornado, more adequately than is done at present from radar reflectivity and echo shape. Since the Doppler spectrum of a tornado must be very wide, corresponding to the strong winds and wind gradients characteristic of that phenomenon, a relatively primitive Doppler capability might prove adequate for operational warning. Of course, the probable small reflectivity of the tornado funnel may be an important difficulty, but we will not really know how important such problems are until we undertake their systematic investigation. It should be noted also that methods for clearly identifying thunderstorms which harbor severe turbulence and tornadoes would have very important applications to basic research in meteorology.

The potential applications of radar to the detection of turbulence and tornadoes illustrate that Doppler-research capabilities of rather ordinary non-coherent radars, not to mention single Doppler radars, are far from exhausted. In fact, relatively simple equipment can be effectively utilized for many important theoretical and practical investigations, and deserves much more attention.

I would emphasize that radar-meteorology programs should be complemented by the inputs from a variety of sensors. Major interests today are more than ever directed to meteorological processes in their interaction rather than in isolation. For example, storm circulations cannot be properly understood without data concerning temperature, winds, and moisture in the clear air environment, and such data can probably not be adequately provided by radar. An observational program to gather meaningful data from a variety of sensors contemporaneously requires expensive facilities and a number of competent investigators working in cooperation toward a shared objective. The development of such cooperative relationships among investigators and the facilities available to them should continue to be encouraged.

Of course, we notice also that there are important singular problems which can be addressed on an ad hoc basis by an individual scientist with a highly specialized objective. Since there are many indirect probing facilities already developed in this country and utilized a rather low percentage of the time, I hope individual scientists will be encouraged to make use of these facilities, and to avoid, where practical, expensive new facilities programs.